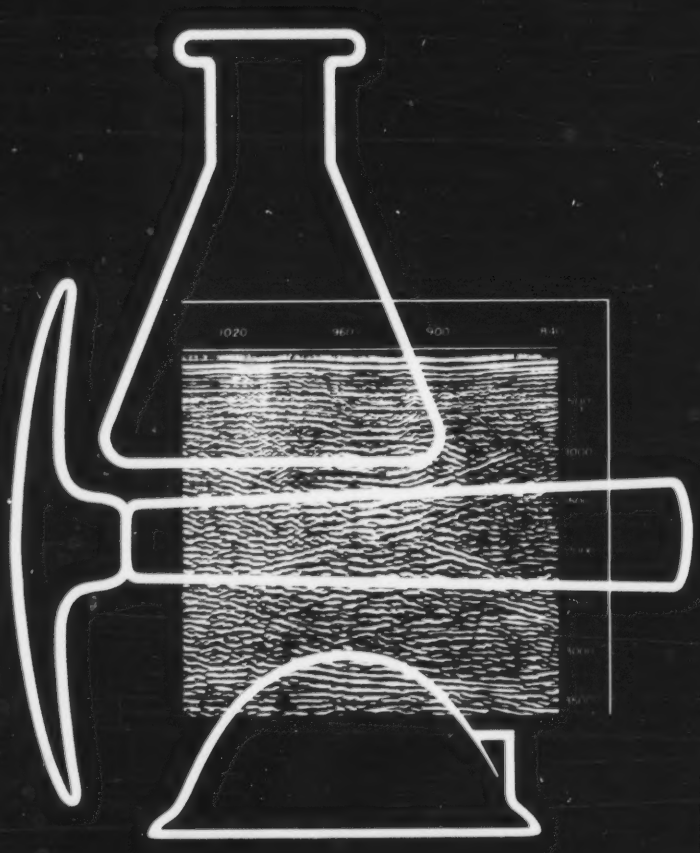
COOPERATION

COOPERATION AGREEMENT ON MINERAL DEVELOPMENT

ENTENTE DE COOPÉRATION L'EXPLOITATION MINÉRAL



Canada

New Brunswick Nouveau-Brunswick

New Nouveau
Brunswick

Natural Resources and Energy
Mineral Resources

Open File Report 92-2

PRELIMINARY METALLURGICAL TESTING OF HIGH-GRADE AND STOCKWORK SAMPLES FROM THE RILEY BROOK MAP AREA, EAST HALF (NTS 21/O3E), VICTORIA COUNTY, NEW BRUNSWICK

R.A.J. May[1], R. Harris[2], and M. O'Donnell[2]

[1] Richard May and Associates
108 Prospect Street West, Suite 5B
Fredericton, N.B.

[2] N.B. Dept. of Natural Resources and Energy
Mineral Resources
Fredericton, N.B.

ISSN 1183-5508

Price $2.00

92-02764/

TABLE OF CONTENTS

		Page
Tables		ii
Illustrations		ii
Abstract		v
1.0	Introduction	1
	1.1 Custom Milling and Further (FCL) Processing	2
2.0	Sample Preparation	2
3.0	Mineralogy	3
4.0	Preliminary Testwork	4
5.0	Testwork Procedure	6
6.0	Testwork Results	8
	6.1 Grinding Results	9
	6.1.1 High-Grade	9
	6.1.2 Stockwork	9
	6.2 Varying Reagent Dosages	10
	6.2.1 High-Grade	10
	6.2.2 Stockwork	12
	6.3 Zinc Depressants	13
7.0	Bathurst Camp Operations	15
8.0	Conclusions	18
9.0	References	19
10.0	Appendix. Location maps of the Riley Brook area and of drill holes that provided source material for the high-grade and stockwork samples	20

TABLES

		Page
Table I:	Head Assays	2
Table II:	Theoretical Mineralogical Composition	4
Table III:	Bond Index Measurements	5
Table IV:	Grinding Results, Stockwork	5
Table V:	Grinding Results, High-Grade	6
Table VI:	Flotation Test Report - Sewell Brook High-Grade	7
Table VII:	Flotation Test Report - Sewell Brook Stockwork	7
Table VIII:	Sewell Brook Flotation Tests - High-Grade	8
Table IX:	Sewell Brook Flotation Tests - Stockwork	8
Table X:	Flotation Testwork, High-Grade	10
Table XI:	Flotation Testwork, Stockwork Lead Rougher Concentrate	12
Table XII:	Flotation Testwork, Stockwork and High-Grade Lead Rougher Concentrate	13

ILLUSTRATIONS

Figure I:	Stockwork-Particle Size Distribution versus Grind Time	5
Figure II:	High-Grade-Particle Size Distribution versus Grind Time	5
Figure III:	Laboratory Test Procedure Flowsheet	6
Figure IV:	High-Grade-Recovery versus Flotation Time for Grind of 58% passing 75 micron	9

Page

Figure V: High-Grade-Recovery versus Flotation Time for Grind of 95% passing 75 micron 9

Figure VI: Stockwork-Recovery versus Flotation Time for Grind of 18% passing 75 micron 10

Figure VII: Stockwork-Recovery versus Flotation Time for Grind of 75% passing 75 micron 10

Figure VIII: High-Grade-Recovery versus Flotation Time for 200 g/t of SIPX 11

Figure IX: High-Grade-Recovery versus Flotation Time for 60 g/t of SIPX 11

Figure X: High-Grade-Recovery versus Flotation Time for 45 g/t of SIPX 11

Figure XI: Stockwork-Recovery versus Flotation Time for 200 g/t of SIPX 12

Figure XII: Stockwork-Recovery versus Flotation Time for 90 g/t of SIPX 12

Figure XIII: Stockwork-Recovery versus Flotation Time for 45 g/t of SIPX 13

Figure XIV: Stockwork-Recovery versus Flotation Time with No Depressant 14

Figure XV: Stockwork-Recovery versus Flotation Time with Low Depressant Dosages 14

Figure XVI: Stockwork-Recovery versus Flotation Time with Higher Depressant Dosages 14

Figure XVII: High-Grade-Recovery versus Flotation without Depressants 15

Figure XVIII: High-Grade-Recovery versus Flotation Time with Depressants 15

Page

Figure XIX: Typical Cu-Pb, Cu, Pb, and Bulk Circuits for Bathurst Camp Concentrators 16

Figure XX: Typical Zinc Circuit for Bathurst Camp Concentrators 17

ABSTRACT

The recent base metal discoveries in the Riley Brook area of northwestern New Brunswick have revealed possible ore bodies in a zone that is geologically different from the currently worked Bathurst camp. In order to provide some preliminary metallurgical data to supplement the geological data, laboratory tests were carried out in the Mineral Processing Laboratory of the Mineral Development Branch of the New Brunswick Department of Natural Resources.

Samples of high grade lead-zinc material and lead-zinc-bearing stockwork were used in the preliminary flotation tests. In addition, Bond Work Indexes were determined for each type of material.

The results demonstrated that bulk concentrates could be produced from both materials and at relatively coarse grinds. Separate lead and zinc concentrates can be produced but it is necessary to use zinc depressants due to the high activation of the sphalerite. The Bond Work Indexes indicate that both types of material require fairly low grinding energy input.

RÉSUMÉ

Les découvertes récentes de métaux communs dans la région du ruisseau Riley, au nord-ouest du Nouveau-Brunswick, ont révélé des corps minéralisés dans une zone géologiquement différente du secteur présentement exploité de Bathurst Camp. On a réalisé des tests de laboratoire au laboratoire de minéralurgie de la Direction de l'exploitation des ressources minières du ministère des Ressources naturelles du Nouveau-Brunswick afin d'obtenir certaines données métallurgiques complétant les données géologiques.

Des échantillons de matières à haute teneur en plomb-zinc et de réseaux irréguliers de plomb-zinc ont été utilisés dans les tests de flottation préliminaires. On a en outre déterminé les indices de Bond de chaque type de matière.

Les résultats ont démontré que l'on pouvait produire des concentrés collectifs à partir des deux types de matières avec des broyages relativement grossiers. Des concentrés séparés de plomb et de zinc peuvent être produits, mais cette séparation exige l'emploi de déprimants de zinc en raison de l'activation élevée de la sphalérite. Les indices de Bond révèlent que les deux types de matières nécessitent un intrant énergétique assez faible pour le broyage.

1.0 INTRODUCTION

Significant base metal (lead and zinc) mineralization was discovered in the Riley Brook area of northwestern New Brunswick. It is now the site of much exploration activity. Geologically, the area forms part of the Tobique - Chaleur zone that extends from Chaleur Bay to areas south of Plaster rock. The discovery was prompted by geological mapping that was carried out by the Mineral Resources Division of the Department of Natural Resources and Energy (Wilson, 1988).

Base metal mining is an important contributor to the provincial economy. The majority of the known copper, lead and zinc mineralization (and hence base metal mining) in the Province occurs within the massive sulphide deposits of the Miramichi zone. This area is referred to as the Bathurst camp (Fyffe et al., 1990, McCutcheon, 1990). The Riley Brook area of the Tobique - Chaleur zone offers a new horizon for base metal exploration and development in the Province (Appendix).

The most significant discovery of the Riley Brook area to date is the Sewell Brook deposit. It is owned by NovaGold Resources Incorporated. In 1991, NovaGold entered an option agreement with Kennecott Canada Inc. for further exploration and possible development. The deposit currently registers less than 100 000 of base metal rich material. Zones grading as much as 30% zinc have been identified.

Little is known of the metallurgy of the Sewell Brook discovery. The Mineral Resources Division of the Department of Natural Resources and Energy proposed and initiated this preliminary study to determine general metallurgical (flotation) properties of the deposit. This data is intended to stimulate further metallurgical studies not only of Sewell Brook but of other base metal discoveries within this geological environment.

Funding was provided under the Mineral Processing Investigation Program (MPIP) of the Canada-New Brunswick Cooperation Agreement on Mineral Development. The aim of the MPIP is to increase the metallurgical knowledge base of promising mineral deposits in New Brunswick and to complement the Division's geological efforts. In turn, it is hoped to stimulate further interest in and development of our resources.

The work program covered grinding and flotation experiments and a basic mineralogical examination using drill core provided by NovaGold. Bond Work Index measurements were taken to determine the ease with which the material can be ground. The aim of the experiments was to determine the flotation grade - recovery responses of the valued minerals (sphalerite and galena) for different grinds, reagents and reagent dosages. Selective versus bulk flotation was also investigated.

1.1 *Custom Milling and Further (FCL) Processing*

Custom milling of small base metal deposits is a development concept that has received consideration for in-province application. This could be a portable mill that could be move from site to site or the temporary use of an existing permanent mill. As an example of the latter, Heath Steele has recently custom milled ore from Stratabound's nearby CNE deposit. This concept offers the potential for the development of smaller deposits that could not support their own dedicated milling facilities. Sewell Brook could become a candidate for custom milling if large tonnages of ore are not found.

Further base metal processing for metal production is a priority for the Province. Ferric chloride leaching technology for the treatment of base metal concentrates is being developed by CANMET (Canada Centre for Minerals and Energy Technology) and others (Craigen et al., 1989). The CANMET process has direct application to New Brunswick. NovaGold has acquired the technology rights from CANMET for commercial development of FCL in New Brunswick and is evaluating its application for its Murray Brook copper/silver deposit. A 500 t/day demonstration plant is proposed for Murray Brook.

The beauty of FCL is that it treats bulk concentrates and does not emit sulphur dioxide. NovaGold plans to prove the copper/silver circuit as the first phase, followed by the addition of lead and zinc circuits. From NovaGold's perspective, Sewell Brook could be the feed source for lead and zinc ore should the deposit be developed.

2.0 SAMPLE PREPARATION

Two samples of complex copper-lead-zinc sulphide materials, a high-grade ore and a low-grade stockwork[1], were obtained for the bench-scale testwork. Each sample was prepared from drill cuttings from several holes (Appendix). The high-grade sample was obtained from drill holes 9108-2D, 9108-4D, 9108-6D, 9108-8D, 9108-9D, 9108-10D, 9108-17D, 9108-18D and 9108-20D. The stockwork sample was obtained from drill holes 9108-1D, 9108-11D to 9108-15D, 9108-19D and 9108-20D. The drill cuttings for both the high-grade and stockwork samples were separately crushed in a jaw crusher to 100 % passing 1.68 mm (10 mesh) and the respective samples were thoroughly mixed using coneing and quartering. Each sample was riffled to produce 2000 g charges for the testwork. Head Assays for the two ore types are presented in Table I, below.

---

[1]Stockwork: A mineral deposit consisting of a three dimensional network of planar to irregular veinlets closely enough spaced that the whole mass can be mined.

Table I: Head Assays

	%						
	Cu	Pb	Zn	Fe	SiO_2	S	As
High-Grade	0.67	6.69	29.10	8.32	18.19	24.4	0.24
Stockwork	0.096	1.70	4.55	7.21	56.40	6.84	0.18

Table I (cont'd)

	ppm							
	Au	Ag	Bi	Cd	Hg	Mo	Sb	Tl
High-Grade	0.65	76	~28	919	23	150	210	>2
Stockwork	0.36	33	~1	106	14	36	130	>2

3.0 MINERALOGY

The Sewell Brook deposits consist of volcanogenic massive sulphides hosted predominately by felsic volcanic rocks and minor volcanogenic sediments.

Mineralogical examination of thin sections taken from various drill cores indicated that generally the sulphide minerals were mainly coarse grained. Galena, sphalerite and chalcopyrite were observed as both free grains and locked together in various combinations. Chalcopyrite and galena occasionally occurred as fine inclusions in sphalerite.

Examinations of various test feeds and flotation concentrates identified the following sulphide minerals in both the stockwork and high-grade samples:

Pyrite, sphalerite, galena, chalcopyrite, covellite, digenite and arsenopyrite

The gangue minerals were predominately quartz and altered volcanic rock (possibly tuffs or pyroclasts). The stockwork samples contained lower amounts of copper minerals than the high-grade.

The observed covellite and digenite content was reported to be less than 0.1 % to 0.3 % of the total area observed. Most of the covellite and digenite occurred in associations with sphalerite and chalcopyrite although free grains were also observed.

The most common mineral associations identified were:

galena/pyrite
sphalerite/pyrite
sphalerite/digenite/covellite
sphalerite/chalcopyrite
sphalerite/galena

For the flotation concentrate, approximately 83 % of the sphalerite in the stockwork and approximately 68 % of the sphalerite in the high-grade material was visually estimated to be free. The flotation feed grind was 95% passing 75 microns for the high-grade and 75% passing 75 microns for the stockwork.

Locked sphalerite mostly occurred in particles coarser than 50 μm. Fine intergrowths of sphalerite with covellite, pyrite or galena in the - 20 μm fraction were also observed.

A theoretical mineralogical make up of the two ores can be estimated using the head assays and assuming that all the copper, lead and zinc are present as chalcopyrite, galena and sphalerite, respectively. Further, the copper content of the chalcopyrite is assumed to be 34 %, the lead content of the galena is assumed to be 87 %, the zinc content of the sphalerite is assumed to be 67 % and the iron content of pyrite is 46 %. This gives the theoretical mineralogical content presented in Table II.

Table II: Theoretical Mineralogical Composition

	High-Grade	Stockwork
Chalcopyrite, %	2.0	0.3
Galena, %	7.7	2.0
Sphalerite, %	43.4	6.8
Pyrite, %	18.1	7.9
SiO_2, %	18.2	56.4
TOTALS	**89.4**	**73.4**

4.0 PRELIMINARY TESTWORK

Prior to the flotation testwork, a Bond Work Index was determined for the Stockwork and High-Grade material. Particle size distributions versus grinding times were established.

The Bond Work Index, which is an estimate of the power requirements for grinding an ore, is determined using a standardized procedure (Allis-Chalmers). Table III presents the Index values for the two sample types.

Table III: Bond Index Measurements

Parameter (KwH/St)	High-Grade	Stockwork
Calculated Bond Work Index	7.20	9.78
Corrected Unit Power Requirement	8.55	11.95

Tables IV and V summarize the results of the grinding versus time experiments using a laboratory scale rod mill for the Stockwork and High-Grade samples, respectively. Figures I and II present similar data in graphical form.

TABLE IV: Grinding Results, Stockwork

Particle Size	Weight % Passing				
μm	15 min	30 min	40 min	45 min	75 min
- 600	85.0	100.0	100.0	100.0	100.0
- 300	53.4	92.0	99.4	100.0	100.0
- 150	22.6	47.6	59.8	69.5	100.0
- 75	3.4	15.1	28.8	18.1	75.4

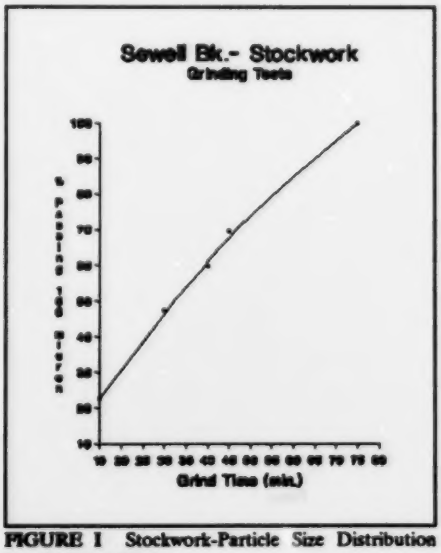


FIGURE I Stockwork-Particle Size Distribution versus Grind Time.

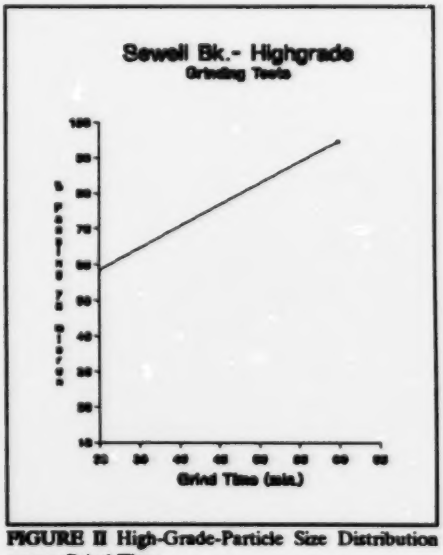


FIGURE II High-Grade-Particle Size Distribution versus Grind Time.

TABLE V: Grinding Results, High-Grade

Particle Size	Weight % Passing	
μm	30 minutes	60 minutes
- 600	100.0	100.0
- 300	100.0	100.0
- 150	95.2	99.9
- 75	58.4	94.5

5.0 TESTWORK PROCEDURE

The procedures followed for all the grinding and flotation tests are given below and in the flowsheet shown in Figure III.

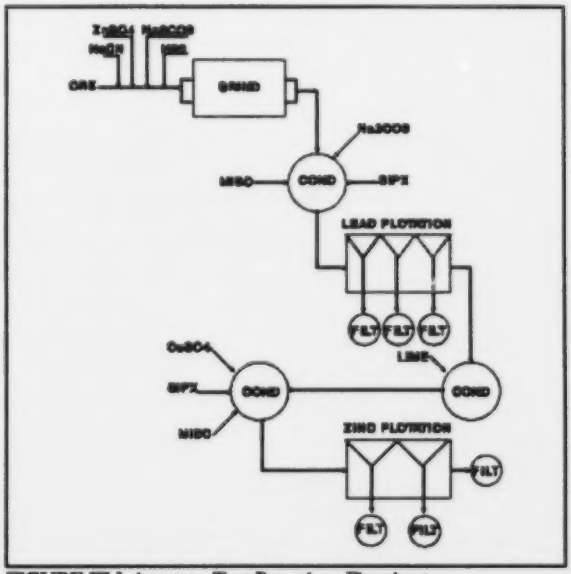


FIGURE III Laboratory Test Procedure Flowsheet

- Grind each 2000 g charge in a laboratory rod mill at 60 % solids until the desired particle size distribution is achieved. Add soda ash, zinc sulphate and sodium cyanide to the mill as required.
- Transfer the ground pulp to the 5 L cell of a Denver laboratory flotation machine, which was operated at 1500 rpm.
- Adjust the pH with more soda ash and then condition the pulp with the required dosages of sodium isopropyl xanthate (SIPX) and MIBC frother.
- Float a concentrate over a given period of time.
- Repeat the reagent additions and flotation steps until the desired number of flotation stages have been run.
- When required, adjust the pH of the remaining pulp with lime. Add copper sulphate and more reagents and float zinc concentrates.

- Filter, dry, weigh and assay each flotation product.

The respective conditions and flotation times for the high-grade and stockwork tests are given in Tables VI and VII.

TABLE VI

Flotation Test Report - Sewell Brook High-Grade											
Operation	Test/Time (min)					Reagent	Test/Quantity (g/t)				
	A	B	C	D	E		A	B	C	D	E
Condition	2	2	2	2	2	SIPX	400	500	60	60	30
Stage 1	1	1	1	1	1	Frother	20	25	10	20	10
Stage 2	1	1	1	1	2	Soda Ash	3500	4000	5500	5500	10000
Stage 3	2	1	1	1	3	Lime	4500	5000	-	-	-
Stage 4	1	1		2		NaCn	-	-	-	-	500
Stage 5	2	1				$ZnSO_4$	-	-	-	-	7500
Stage 6	5	1				$CuSO_4$	400	300	-	-	-
Stage 7	5	2									

TABLE VII

Flotation Test Report - Sewell Brook Stockwork												
Operation	Test/Time (min)						Reagent	Test/Quantity (g/t)					
	A	B	C	D	E	F		A	B	C	D	E	F
Condition	2	2	2	2	2	2	SIPX	500	400	90	45	45	45
Stage 1	1	1	2	1	1		Frother	25	20	15	15	15	15
Stage 2	2	1	2	2	2	2	Soda Ash	1250	2500	3500	3500	3500	7500
Stage 3	1	1	3	2	3	2	Lime	2750	5000	-	-	-	7500
Stage 4	1	2				2	NaCn	-	-	-	-	-	500
Stage 5	3	1					$ZnSO_4$	-	-	-	-	2500	7500
Stage 6	2	2					$CuSO_4$	400	200	-	-	-	500
Stage 7	2	3											

6.0 TESTWORK RESULTS

The primary objective of the flotation testwork was to determine what types of concentrates could be produced and at what grades and recoveries of the major metals. Variables that were investigated included fineness of grind of the flotation feed, reagent dosages and the use of selective depressants. The results of the flotation tests have been summarized in Tables VIII (High-Grade) and IX (Stockwork).

TABLE VIII

Sewell Brook Flotation Tests - High-Grade

Test	Lead Conc.					Zinc Conc.					Tails				
	Weight %	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	Weight %	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	
A	56.4	8.9	39.9	81.7	74.5	22.0	3.5	33.7	12.5	24.6	1.7	1.3	5.8	0.9	
B	46.6	11.2	35.4	82.9	54.8	29.8	12.0	44.0	12.0	44.0	1.4	1.5	5.1	1.2	
C	23.0	16.6	25.3	57.1	20.0						3.2	32.1	39.1	80.9	
D	51.1	12.7	32.3	90.0	54.0						1.5	28.8	10.0	46.0	
E	14.2	33.8	17.6	79.9	7.9						1.4	34.0	20.3	92.1	

TABLE IX

Sewell Brook Flotation Tests - Stockwork

Test	Lead Conc.					Zinc Conc.					Tails				
	Weight %	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	Weight %	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	Grade Pb%	Grade Zn%	Distribution Pb%	Distribution Zn%	
A	18.0	6.4	23.8	68.1	89.4	2.2	2.0	5.9	2.6	2.8	0.5	0.5	24.5	7.8	
B	17.5	6.5	22.0	66.7	84.6	4.7	2.4	8.6	6.4	8.7	0.4	0.3	20.9	5.5	
C	20.1	5.8	19.5	75.0	86.3						0.5	0.8	25.0	13.7	
D	25.6	4.8	15.4	77.4	86.2						0.5	0.9	22.6	13.8	
E	23.8	5.1	12.3	77.5	64.2						0.5	2.2	22.5	35.8	
F	10.2	11.1	11.2	71.6	23.8	1.1	2.2	12.5	1.6	2.9	0.5	3.4	26.8	73.2	

6.1 *Grinding Results*

6 1.1 High-Grade

Two grinds were investigated, 58.4 passing 75 μm (200 mesh) and 94.5 % passing 75 μm (200 mesh). Reagents additions of 100 g/t SIPX to the first and third stages and flotation times of 1, 1 and 2 minutes for the lead roughers were the same for both tests. Metal recoveries versus flotation time are presented in Figures IV and V. Using a finer grind did result in a higher lead rougher concentrate grade (11.2 % versus 8.9 %) at approximately the same recovery (82.9 % versus 81.7 %). Zinc recovery dropped from 74.5 % to 54.8 % while the zinc grade decreased by 4.5 % to 35.4 %.

For the remaining tests with the high-grade sample, a grind of 94.5 % passing 75 μm (200 mesh) was used.

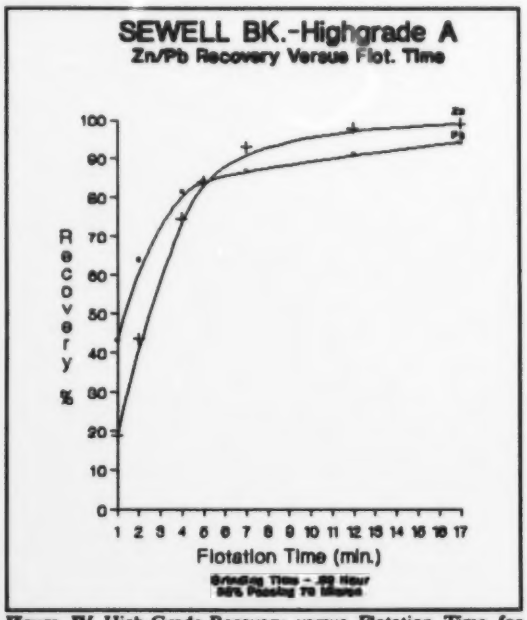


Figure IV High-Grade-Recovery versus Flotation Time for Grind of 58% passing 75 micron

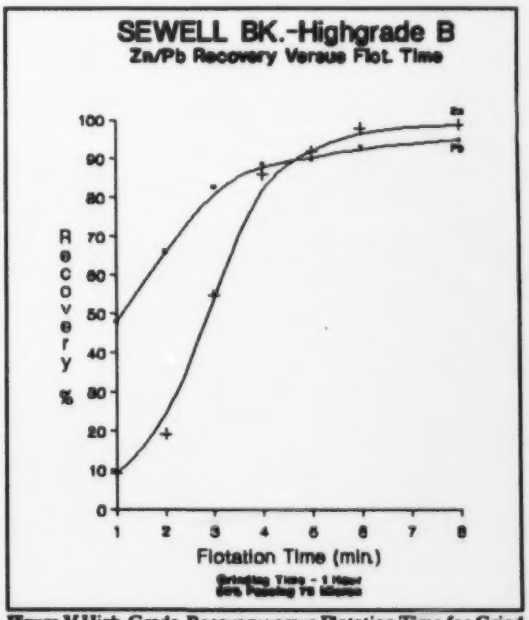


Figure V High-Grade-Recovery versus Flotation Time for Grind of 95% passing 75 micron.

6.1.2 Stockwork

Grinds of 18.1 % passing 75 μm (200 mesh) and 75.4 % passing 75 μm (200 mesh) were tested. Reagent additions were 100 g/t of SIPX to the first and third stages; the lead rougher flotation time was 4 minutes. Zinc recovery of 84.6 % at the finer grind was not significantly reduced from 89.4 %. Lead grades and recoveries and the zinc grade remained relatively unchanged. Figures VI and VII show metal recoveries versus flotation time. The finer grind was used for the remaining tests since the potential for the flotation of any locked sphalerite particles would be reduced.

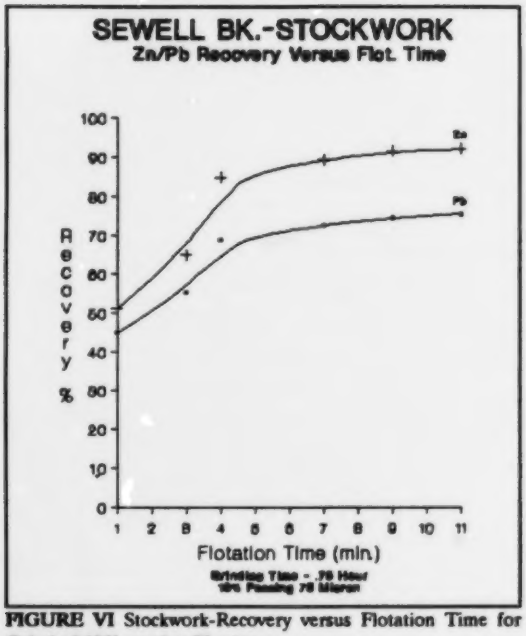


FIGURE VI Stockwork-Recovery versus Flotation Time for Grind of 18% passing 75 micron.

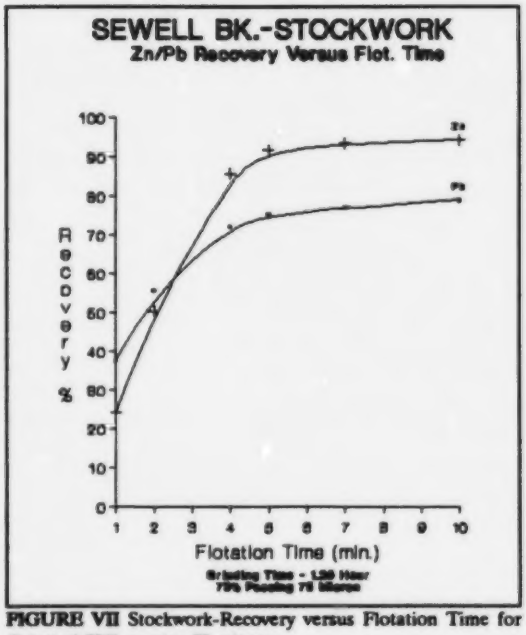


FIGURE VII Stockwork-Recovery versus Flotation Time for Grind of 75% passing 75 micron.

6.2 *Varying Reagent Dosages*

6.2.1 High-Grade

Reagents that were used were soda ash, SIPX, MIBC, lime and copper sulphate. Soda ash was added to the grind and the flotation pH was adjusted to approximately 8.5 with more soda ash. Therefore, the soda ash dosage varied due to variations in the amount needed to achieve the desired pH. Copper sulphate was used as a zinc activator and lime was used to adjust the pH of the zinc flotation stage. Requirements for these two reagents were not quantified since the emphasis of the testing became zinc depression.

SIPX dosages for the three tests were 200 and 60 g/t added in equal amounts to the first and third lead rougher flotation stages and 45 g/t added in equal dosages to each lead rougher flotation stage. The results of these tests are shown in Table X and Figures VIII, IX and X.

Table X: Flotation Testwork, High-Grade

Test No	Dosage g/t	Grade, %		Distribution, %	
		Pb	Zn	Pb	Zn
HG-B	200	11.2	35.4	82.9	54.8
HG-C	60	16.6	25.3	60.9	19.1
HG-D	45	13.3	25.6	81.5	32.6

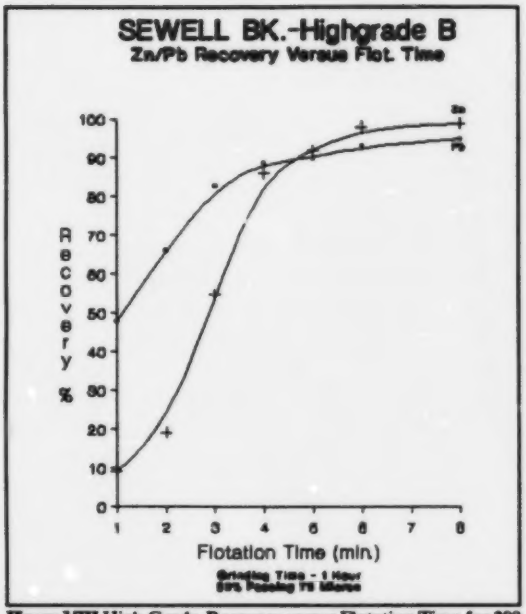


Figure VIII High Grade-Recovery versus Flotation Time for 200 g/t of SIPX.

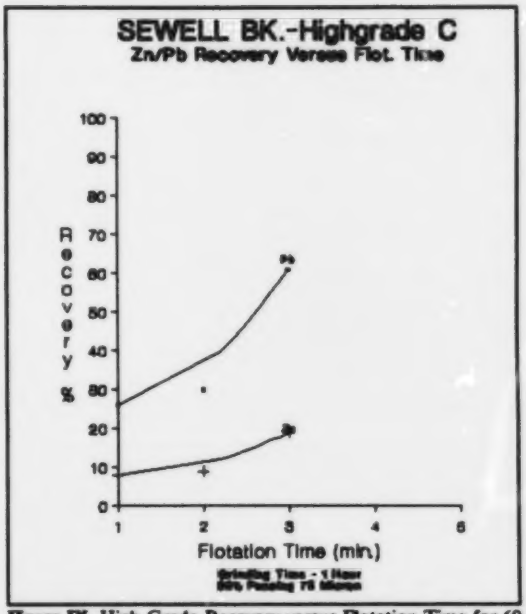


Figure IX High Grade-Recovery versus Flotation Time for 60 g/t of SIPX.

The results show that using less collector does provide more selective flotation. The results of Test C are anomalous and the poorer lead flotation response may have been due to the coarser grind used in this test (94.5 % passing 75 μm rather than 100 %).

An alternative to producing lead and zinc concentrates is to produce a bulk lead-zinc concentrate and a zinc concentrate. The results for the lead rougher concentrate from Test HG-B are close to being an acceptable bulk concentrate. Further, a zinc concentrate, grading 44 % Zn and 2.5 % Pb and containing 44 % of the zinc, was floated after the lead flotation.

Similarly, the lead rougher tailings from Test D graded 33.7 % Zn and contained 67.4 % of the zinc. These results include one flotation product that was collected as a lead scavenger, but assayed 53.3 % Zn and contained 21.4 % of the zinc.

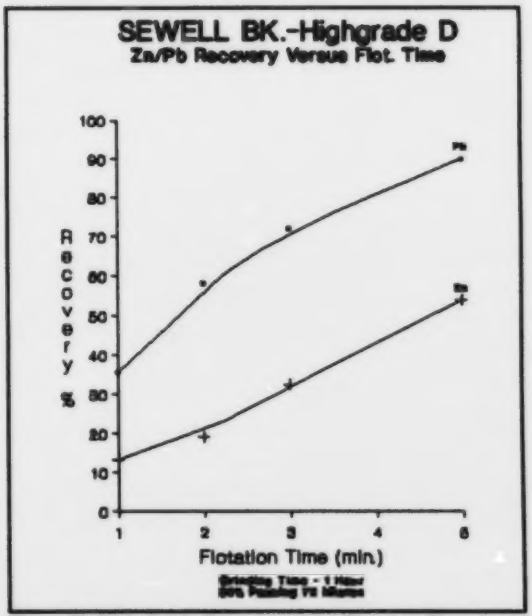


Figure X High Grade-Recovery versus Flotation Time for 45 g/t of SIPX.

6.2.2 Stockwork

As with the high-grade sample, the collector dosage was varied from 200 g/t, added in equal amounts to the first and third lead rougher flotation stage, to 90 g/t and 45 g/t added in equal amounts to each flotation stage. Table XI summarizes these results while Figures XI,XII and XIII show the relevant metal recovery versus flotation time curves.

These results show that the sphalerite in this sample is highly activated and that even at 45 g/t of collector very high zinc recoveries into the lead concentrate were achieved.

Table XI: Flotation Testwork, Stockwork
Lead Rougher Concentrate

Test	Dosage g/t	Grade, %		Distribution, %	
		Pb	Zn	Pb	Zn
ST-B	200	6.5	22.0	72.2	85.7
ST-C	90	5.9	19.5	75.0	86.3
ST-D	45	4.8	15.4	77.4	86.2

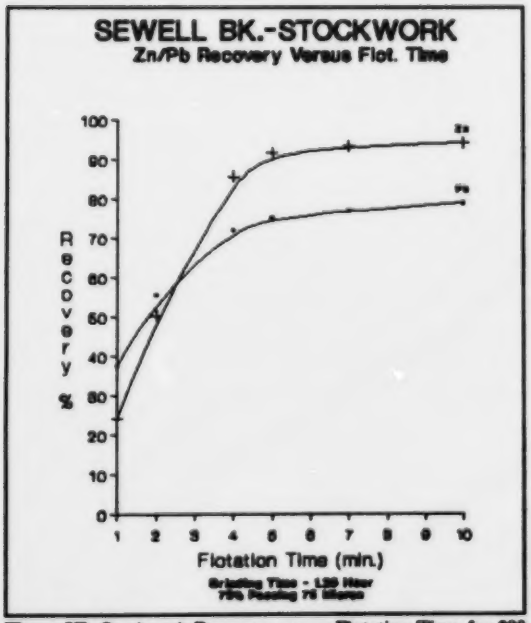


Figure XI Stockwork-Recovery versus Flotation Time for 200 g/t of SIPX.

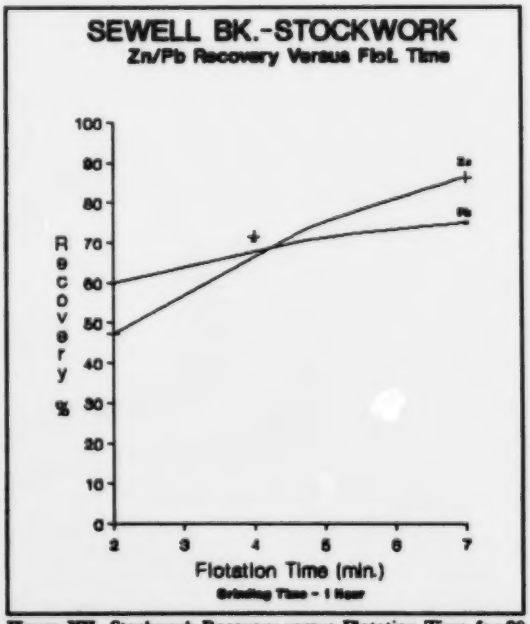


Figure XII Stockwork-Recovery versus Flotation Time for 90 g/t of SIPX.

As with the high-grade sample, the production of a bulk concentrate may be a viable alternative. High recoveries of lead and zinc into a bulk rougher concentrate can be achieved at a coarse grind (eg., Test ST-A with a grind of 18 % passing 75 μm (200 mesh) graded 6.4 % Pb and 23.8 % Zn and produced recoveries of 68 % Pb and 89.4 % Zn.

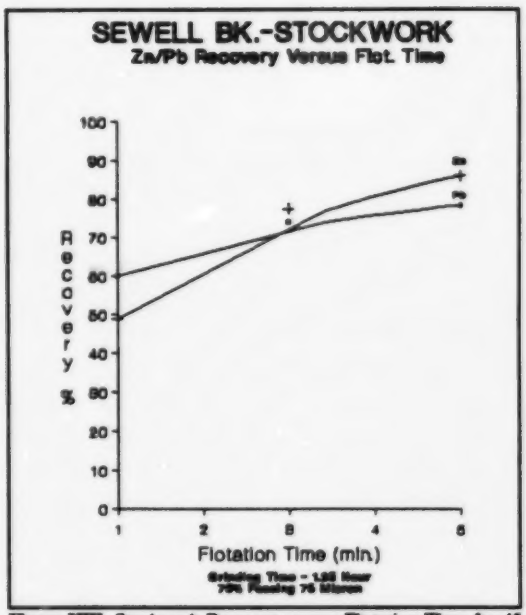


Figure XIII Stockwork-Recovery versus Flotation Time for 45 g/t of SIPX.

6.3 *Zinc Depressants*

The flotation results and the mineralogical examinations had indicated that most of the sphalerite floating was free and was therefore being activated. Zinc sulphate was tested as a depressant with the stockwork and this was followed by testing zinc sulphate and sodium cyanide on both ore types. The zinc sulphate and sodium cyanide were added to the grind. The results of these tests have been summarized below in Table XII and in Figures XIV, XV, XVI, XVII and XVIII.

The results indicate that zinc sulphate and sodium cyanide are good sphalerite depressants. Based on these results, it should be possible to produce separate concentrates.

Table XII: Flotation Testwork, Stockwork and High-Grade Lead Rougher Concentrate

Ore Type	Test No.	$ZnSO_4$ g/t	NaCN g/t	Grade %		Recovery %	
				Pb	Zn	Pb	Zn
Stockwork	ST-D	0	0	4.8	15.4	77.4	86.2
	ST-E	2500	0	5.1	12.3	77.5	64.2
	ST-F	7500	500	11.1	11.2	71.6	23.8
High-Grade	HG-D	0	0	13.3	25.6	81.5	32.6
	HG-E	7500	500	33.9	17.6	79.7	7.9

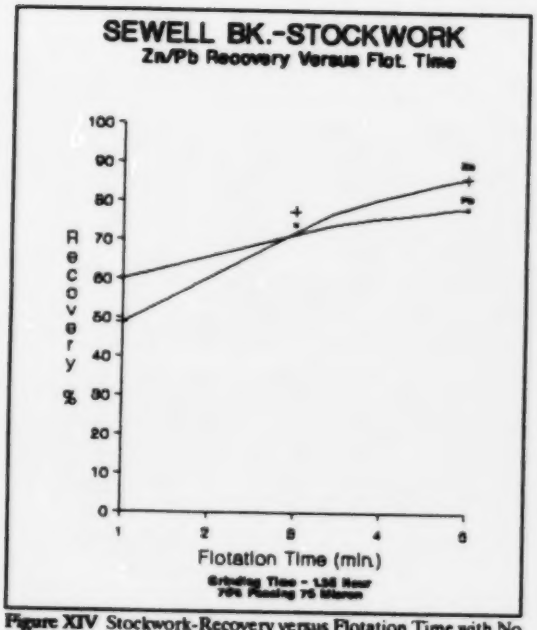


Figure XIV Stockwork-Recovery versus Flotation Time with No Depressant.

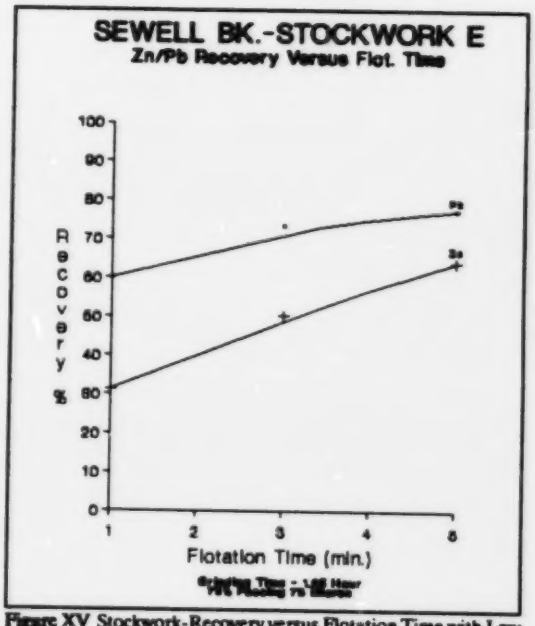


Figure XV Stockwork-Recovery versus Flotation Time with Low Depressant Dosages.

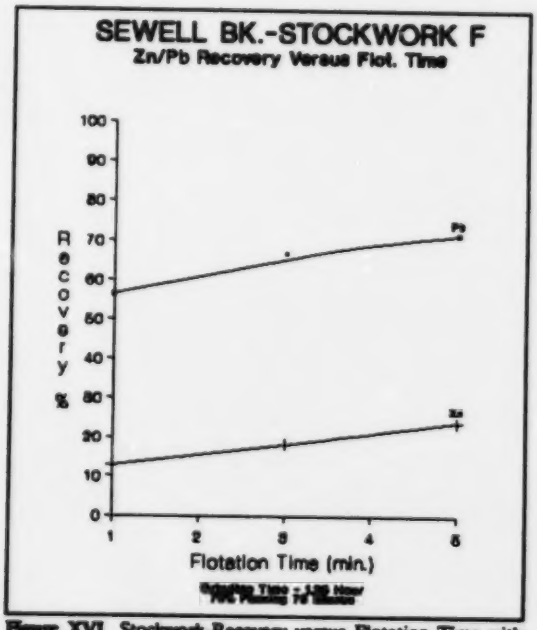


Figure XVI Stockwork-Recovery versus Flotation Time with Higher Depressant Dosages.

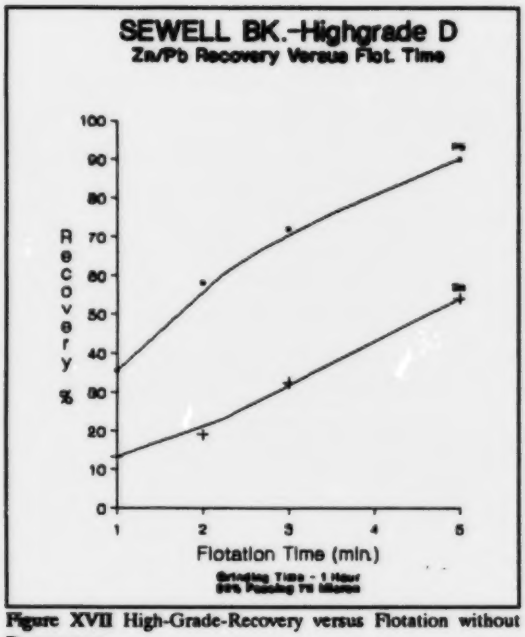


Figure XVII High-Grade-Recovery versus Flotation without Depressants.

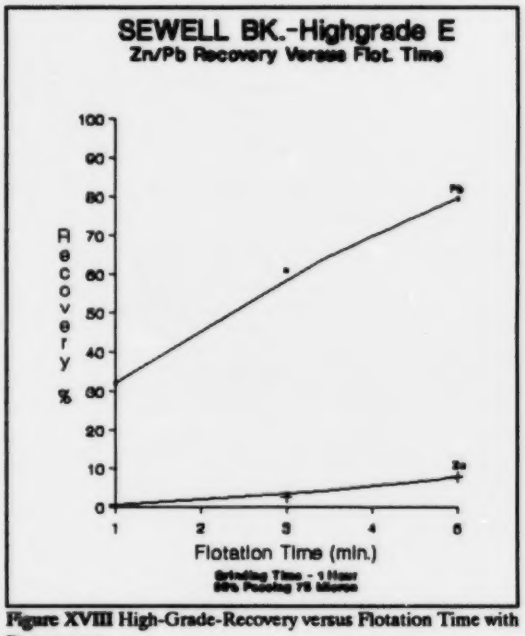


Figure XVIII High-Grade-Recovery versus Flotation Time with Depressants.

7.0 BATHURST CAMP OPERATIONS

There are two concentrators operating in the Bathurst camp: Brunswick Mining and Smelting Corporation Limited (11,000 t/d) and Heath Steele Mines (2800 t/d). A third concentrator, East West Caribou Mining Limited, is currently inactive. The Brunswick mine is an underground operation while the Heath Steele mine is both an underground and open pit operation. As well, the Heath Steele mill has been intermittently used to custom mill ore from the nearby CNE orebody. Both Brunswick and Heath Steele use basically the same process flowsheet that produces a combination of selective and bulk base metal concentrates (See Figures XIX and XX) (Ounpuu et al., 1987; Dechert and DiCarlo, 1991). Grinds in the order of 400 mesh or finer are required to achieved good liberation and hence recovery of the economic minerals.

For Brunswick or Heath Steele, the ore is stage crushed and then fed to rod mills followed by ball mills. Sulphur dioxide is added to the grind along with soda ash. After grinding, the pulp is aerated. Differential flotation is achieved by first floating a copper/lead concentrate that reports to a copper/lead separation circuit. The tailings stream is fed to the zinc circuit for zinc recovery. Concentrate from Cu-Pb separation is cleaned to produce a final copper concentrate while the tails report to the lead upgrading circuit for final lead concentrate production. Tailings from this circuit may be fed to a bulk circuit or form the plant tails.

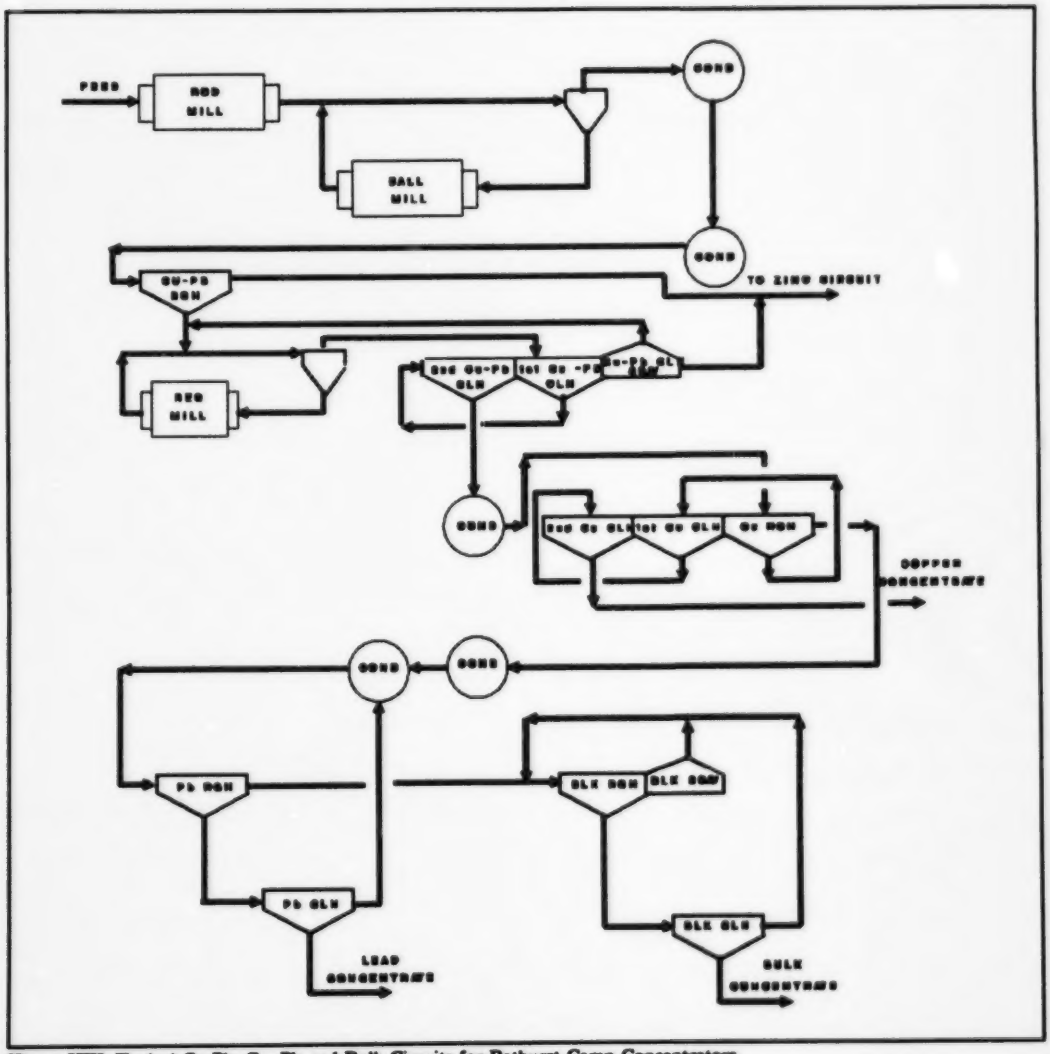


Figure XIX Typical Cu-Pb, Cu, Pb and Bulk Circuits for Bathurst Camp Concentrators.

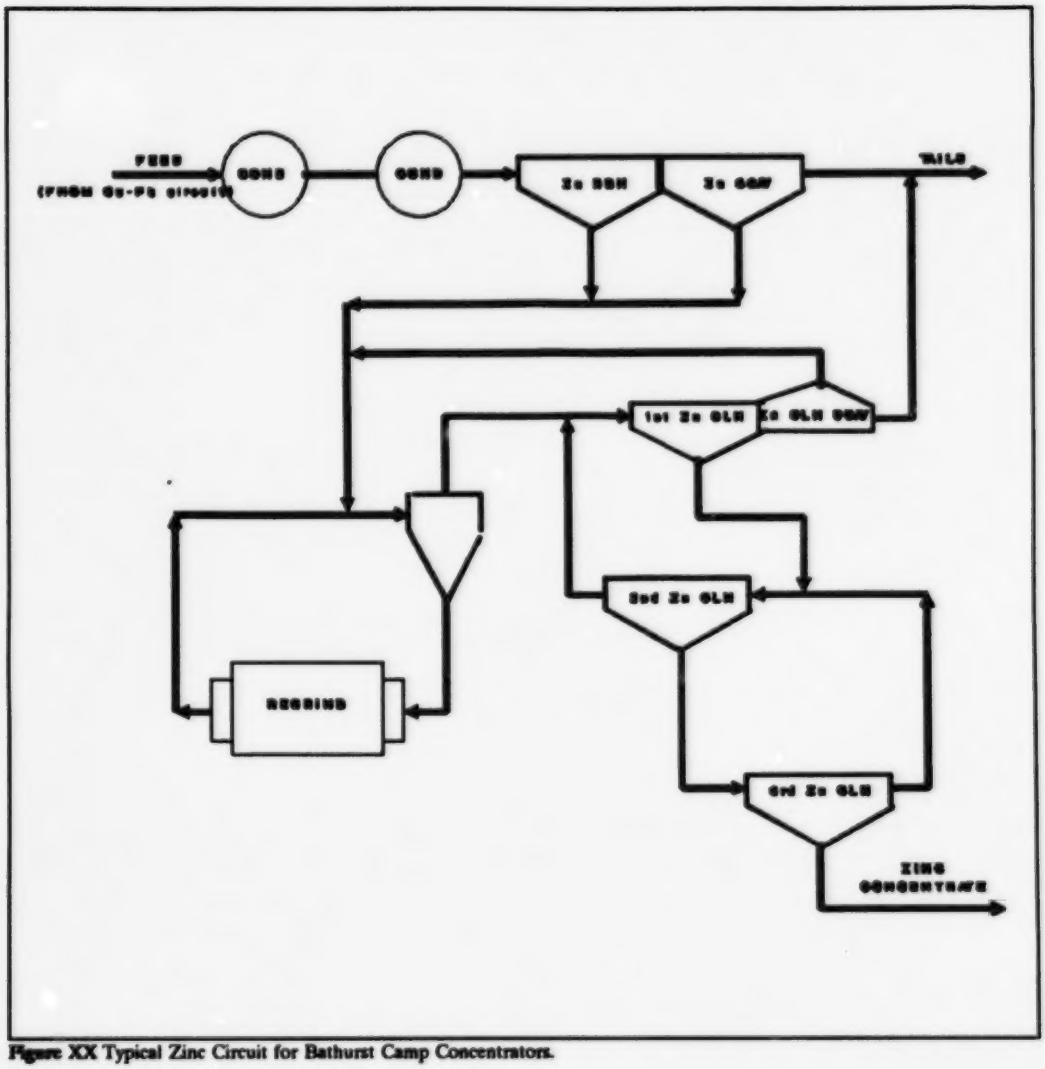


Figure XX Typical Zinc Circuit for Bathurst Camp Concentrators.

The feed to the zinc circuit undergoes rougher flotation followed by three stages of cleaner flotation to produce a final zinc concentrate. The zinc rougher concentrate is reground prior to cleaning.

It is probable that a Bathurst camp type flowsheet could be used to treat Sewell Brook area ores. The results from the laboratory testwork, however, indicate that the flowsheet could be simplified. Good results were obtained at a much coarser grind both for production of a bulk concentrate and separate lead and zinc concentrates. The results indicate that bulk concentrates could be produced in a rougher flotation stage followed by

cleaning. The production of the bulk concentrate is enhanced by the natural activation of the sphalerite.

The laboratory results show that neither SO_2 nor aeration conditioning are required to produce separate lead and zinc concentrates. Also, various upgrading circuits, which are required for Bathurst camp ores, do not appear to be necessary. On the other hand, zinc depressants are required to counteract the natural activation of the sphalerite in Sewell Brook. Although detailed reagent testing was not the purpose of this preliminary laboratory programme, sodium isopropyl xanthate (SIPX) produced good results. More selective collectors could enhance the results.

8.0 CONCLUSIONS

The preliminary metallurgical testing has shown that:

- Separate lead and zinc concentrates can probably be produced from both the high-grade and stockwork when using suitable sphalerite depressants.
- Bulk concentrates can be readily recovered from both sample types.
- Most of the sphalerite that is floating in the lead rougher concentrates is free and is therefore activated.
- Covellite and digenite were present in both samples and are the most probable causes of zinc activation.
- Good recoveries can be achieved at grinds coarser than either Brunswick or Heath Steele.

9.0 REFERENCES

Allis-Chalmers, Procedure for Grindability Tests. Bond Work Indexes Mill Instruction Manual.

Craigin, W.J.S. and CANMET/MSL Staff. 1989. The CANMET Ferric Chloride Leach Process for the Treatment of Bulk Base Metal Sulphide Concentrates. CANMET Mineral Sciences Laboratories Division, Report MSL 89-67 (OP).

Dechert, C. and DiCarlo, S. 1991. The Heath Steele Story. Paper Presented at the 29th New Brunswick Branch C.I.M. Mini Convention, Bathurst, New Brunswick, September.

Fyffe, L.R., Van Staal, C.R. and Winchester, J.A. 1990. Late Precambrian - Early Paleozoic volcanic regimes and associated massive sulphide deposits in the northeastern mainland Appalachians. Canadian Institute of Mining and Metallurgy Bulletin, 83, No. 938, pp. 70-78.

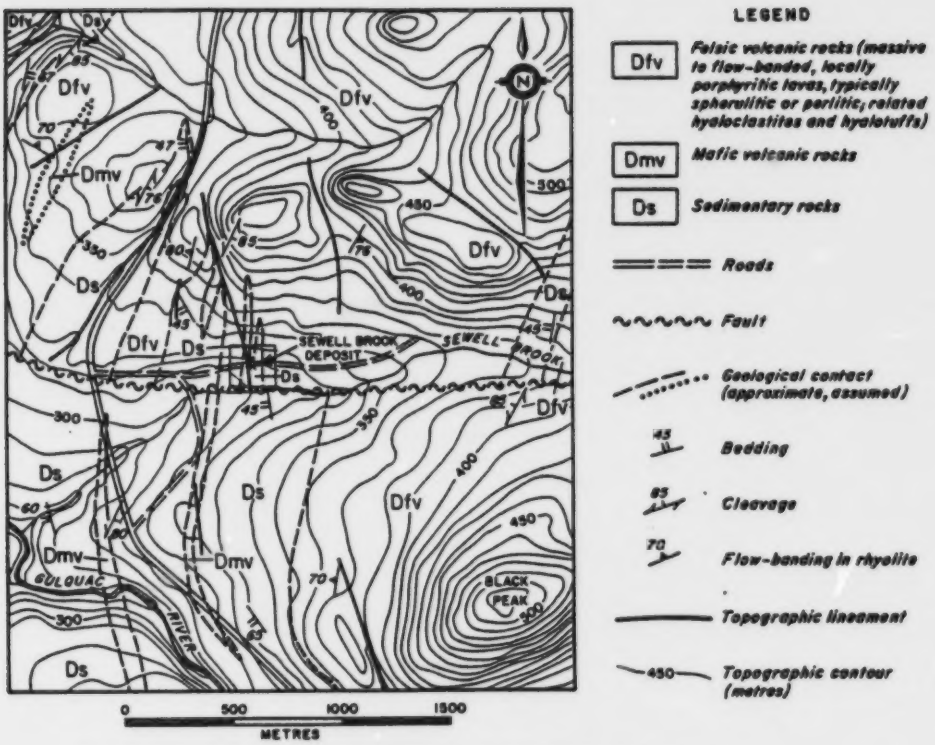
McCutcheon, S.R. 1990. Base metal deposits of the Bathurst-Newcastle district. In Field Guide to Massive Sulphide Deposits in Northern New Brunswick. Edited by L.R. Fyffe. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, pp. 42-71.

Wilson, R.A. 1988. Preliminary geology and lithogeochemistry of selected rock samples, Riley Brook map area, east half (NTS 21 0/3E), Victoria County, New Brunswick. New Brunswick Department of Natural Resources and Energy, Mineral and Energy Division. Geological Notes Series PM 91-1.

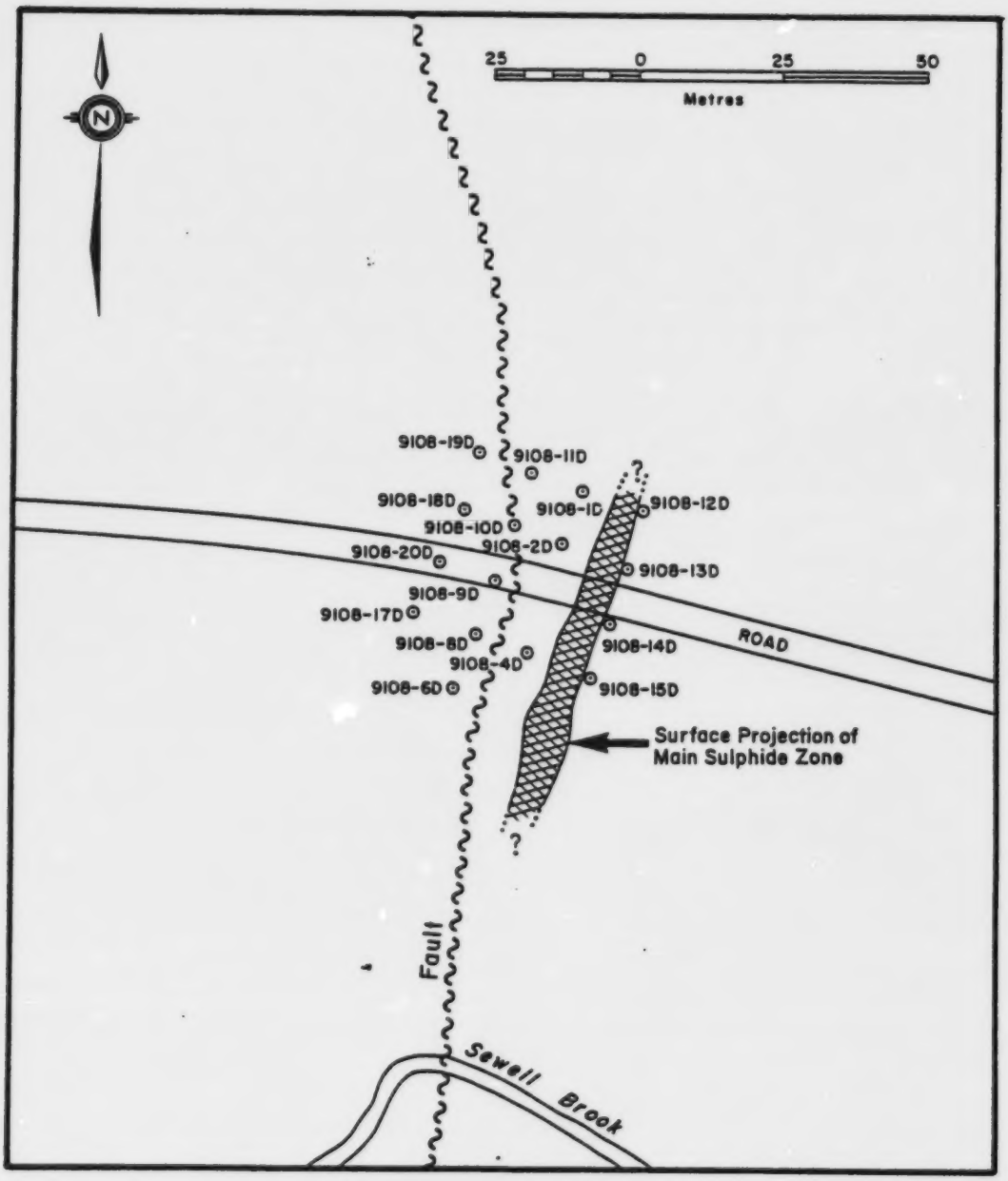
Wilson, R.A. In Press. Petrographic features of Siluro-Devonian felsic volcanic rocks in the Riley Brook area, Tobique Zone, New Brunswick: implications for base metal mineralization at Sewell Brook. Atlantic Geology.

10.0 APPENDIX

Location maps of the Riley Brook area and of drill holes that provided source material for the high-grade and stockwork samples.



Location of the Sewell Brook deposit within the Riley Brook area (21 O/3E), Victoria County, New Brunswick. (Wilson, in press)



Location of the drill holes within the Sewell Brook deposit (modified from Wilson, in press)